



AMSAT-NA Symposium

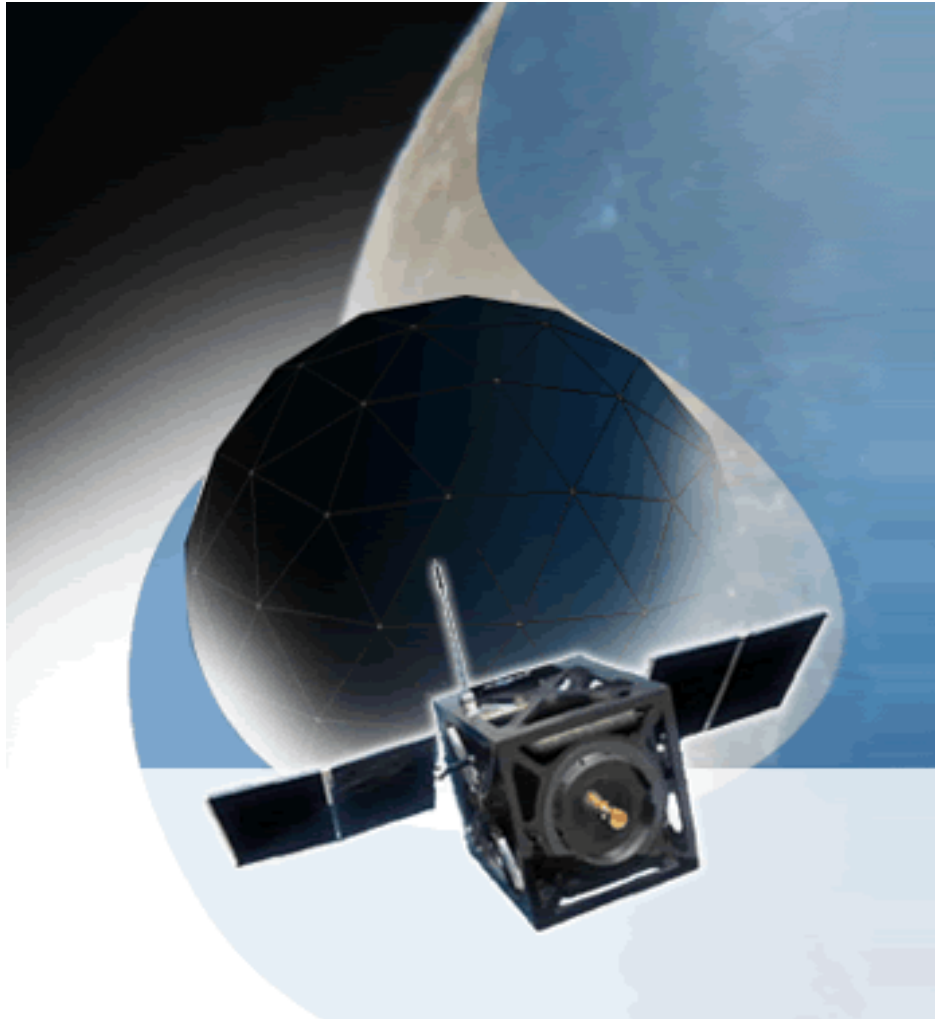
Washington October 2004

“ **AMSAT-UK** hitching a ride on SSETI Express”

Graham Shirville G3VZV – AMSAT-UK

Based on information provided by Mr Neil Melville - SSETI Express Project Manager

ESA Education Office



Student Space Exploration
& Technology Initiative

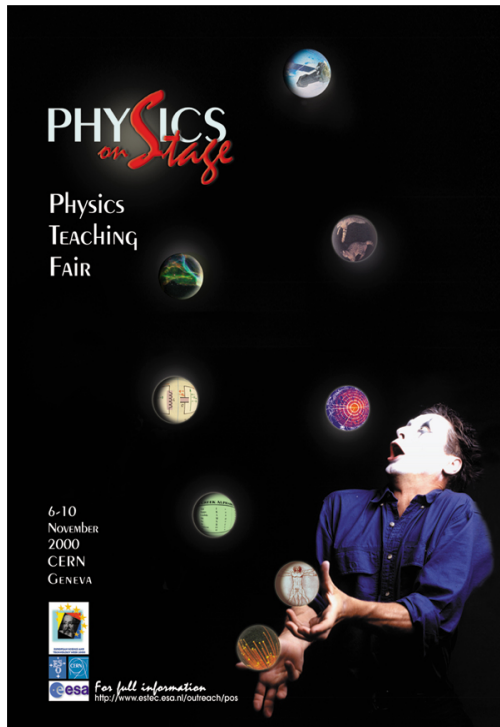
www.sseti.net

A Bit Of Context

- What does the ESA Education Office **do**?
- Aims to challenge and motivate a significant number of young people to enhance their literacy in science and technology in general, and space in particular.
- Identify competent and creative individuals for the mutual benefit of themselves and the Agency, favouring a highly talented workforce for the 21st century
- Achieve this through a mixture of curriculum support and development in primary and secondary levels, and **hands-on** projects at tertiary level

Some of the Projects

Physics On Stage



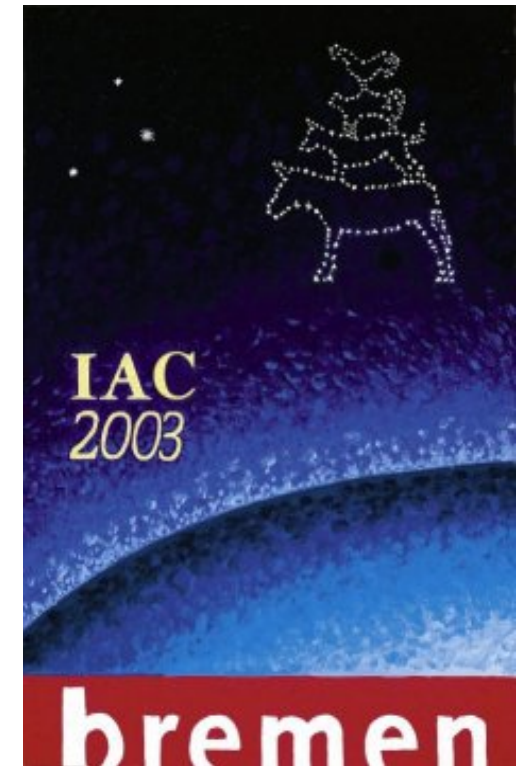
Annual campaigns of 120 students each. Best experiments selected for sixty 20-second parabolas



Sharing of teaching techniques, ideas, aids, demonstrations.

Parabolic Flight Campaigns

Conferences (IAF)



Student sponsorship and participation. Generation handover.

Broad Initiative

- Facilitating the conception, design, development, implementation, launch and operation of educational spacecraft by university students
- Created in October 2000 by the ESA Education Office

Pan-European

- Over two hundred active student participants
- More than twenty major European universities
- Involving young enthusiasts from more than ten European countries

Distributed Structure

- Distributed design, finances and subsystem-level management
- Localised student teams focus on specific tasks or subsystems
- Enables a broad perspective from a much larger overall team than co-location allows
- National or regional expertise can be directly harnessed
- Centralised overall programme management (Education Office)

SSETI Association

- Formed in June 2003 **by** the SSETI students **for** the SSETI students
- Formal Association structure with executive board (President, secretary, etc). SSETI student teams are full members, ESA is an honorary member.
- Statutes and regulations ensure coordination of responsibilities and minimal managerial control
- Provides a legal framework to the initiative
- Allows the SSETI students as a whole to accrue and utilise financial resources
- Tri-partite agreements formed for stability and clarity between the SSETI Association, the host universities and ESA

Working With Students

Benefits

- **HUGE RESOURCE** - There are thousands of 'em...
- **ENTHUSIASM** - Challenge, inspire, motivate and the results are amazingly productive
- **FREE TIME** - Most have it, but those that don't can make it
- **INSANITY** - They are nuts. It's great.
- **EDUCATIONAL** - Very rewarding to see young students learning through doing, preparing and equipping them for their futures

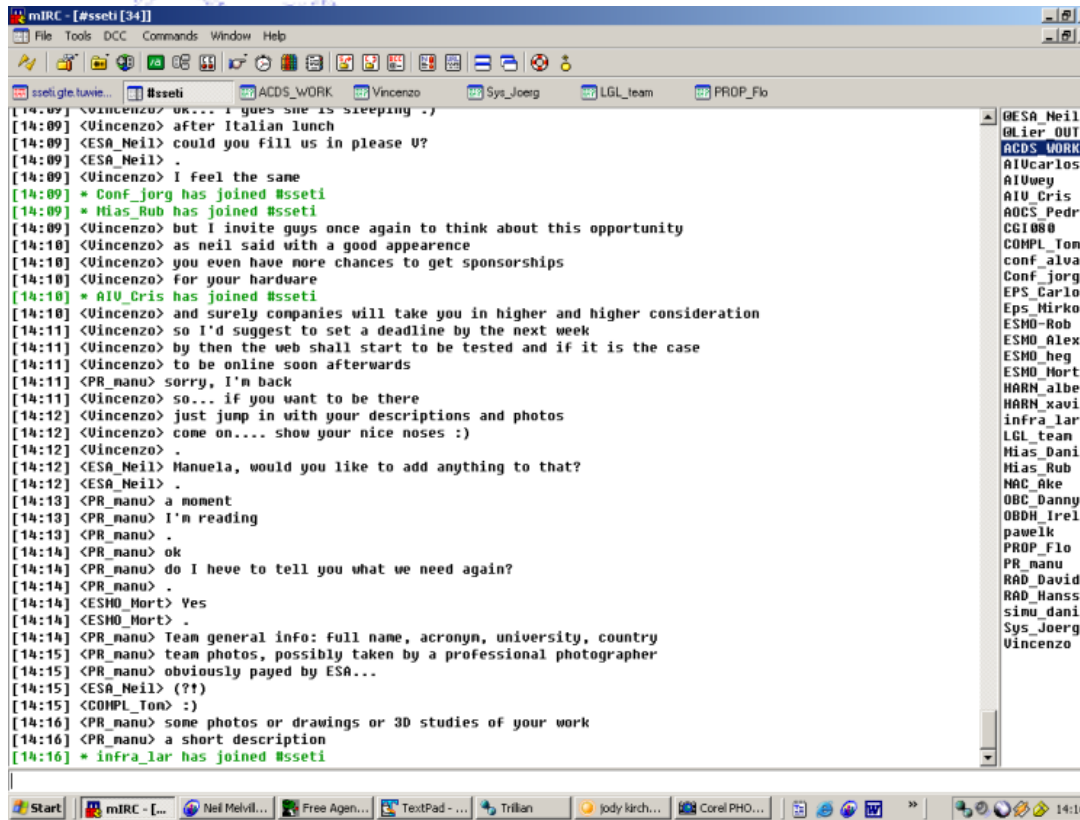
Drawbacks

- **SHORT ATTENTION SPAN** - Hard to keep them motivated
- **VARIABLE SCHEDULES** - Vacations, exams, deadlines, graduation
- **REPETITION, REPETITION, REPETITION** - Gotta keep telling them

But it's worth it!

Communication Tools

- Distributed team ensures that excellent communication is **IMPERATIVE**
- Internet Relay Chat:** An IRC server is used for weekly programme, project and ad-hoc meetings. This also allows a permanent managerial virtual presence and **all** traffic is logged.



mIRC - [#sseti [34]]

File Tools DCC Commands Window Help

sseti gle.tuwie... #sseti ACDS_WORK Vincenzo Sys_Joerg LGL_team PROP_Flo

[14:09] <Vincenzo> ok... I guess she is sleeping :)

[14:09] <Vincenzo> after Italian lunch

[14:09] <ESA_Neil> could you fill us in please V?

[14:09] <ESA_Neil> .

[14:09] <Vincenzo> I feel the same

[14:09] * Conf_jorg has joined #sseti

[14:09] * Hias_Rub has joined #sseti

[14:09] <Vincenzo> but I invite guys once again to think about this opportunity

[14:10] <Vincenzo> as neil said with a good appearance

[14:10] <Vincenzo> you even have more chances to get sponsorships

[14:10] <Vincenzo> for your hardware

[14:10] * AlU_Cris has joined #sseti

[14:10] <Vincenzo> and surely companies will take you in higher and higher consideration

[14:11] <Vincenzo> so I'd suggest to set a deadline by the next week

[14:11] <Vincenzo> by then the web shall start to be tested and if it is the case

[14:11] <Vincenzo> to be online soon afterwards

[14:11] <PR_manu> sorry, I'm back

[14:11] <Vincenzo> so... if you want to be there

[14:12] <Vincenzo> just jump in with your descriptions and photos

[14:12] <Vincenzo> come on.... show your nice noses :)

[14:12] <Vincenzo> .

[14:12] <ESA_Neil> Manuela, would you like to add anything to that?

[14:12] <ESA_Neil> .

[14:13] <PR_manu> a moment

[14:13] <PR_manu> I'm reading

[14:13] <PR_manu> .

[14:14] <PR_manu> ok

[14:14] <PR_manu> do I have to tell you what we need again?

[14:14] <PR_manu> .

[14:14] <ESH0_Mort> Yes

[14:14] <ESH0_Mort> .

[14:14] <PR_manu> Team general info: full name, acronym, university, country

[14:15] <PR_manu> team photos, possibly taken by a professional photographer

[14:15] <PR_manu> obviously payed by ESA...

[14:15] <ESA_Neil> (?)

[14:15] <CONPL_Ton> :)

[14:16] <PR_manu> some photos or drawings or 3D studies of your work

[14:16] <PR_manu> a short description

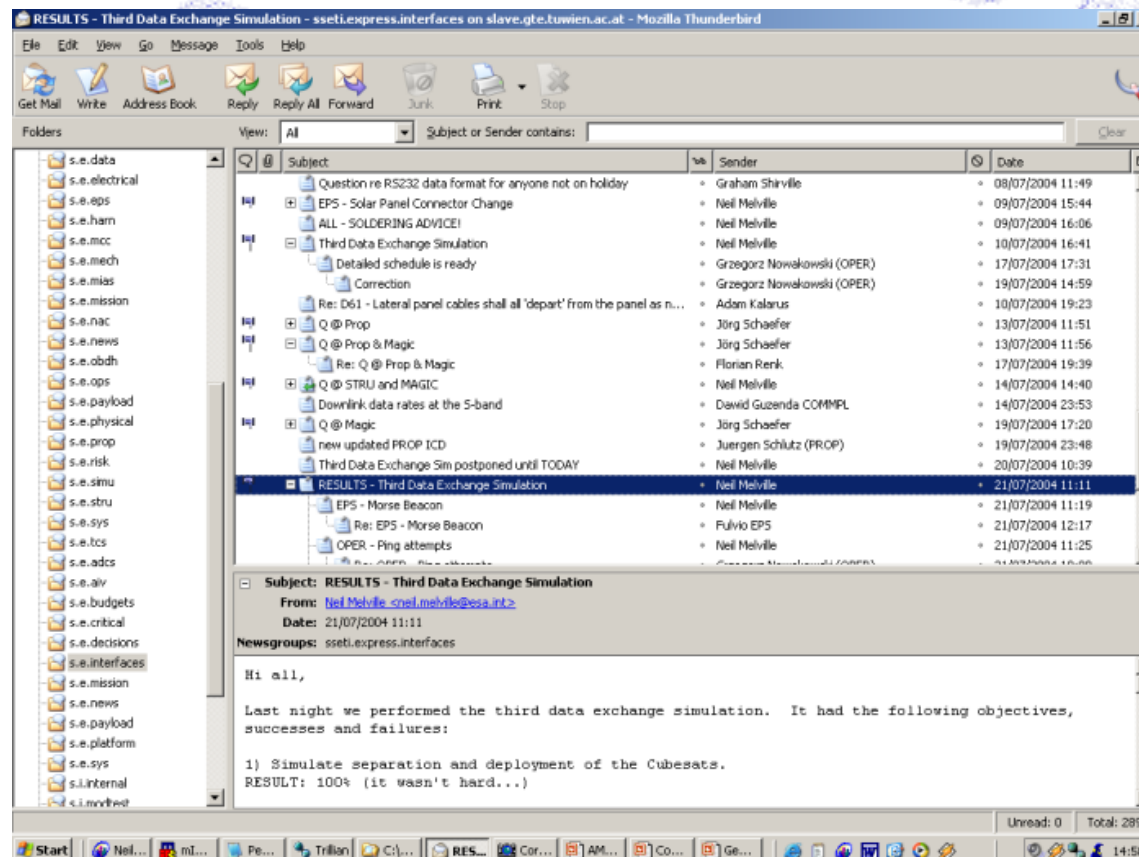
[14:16] * infra_lar has joined #sseti

ESA_Neil
OLIER_OUT
ACDS_WORK
AlUcarlos
AlUuey
AlU_Cris
ACDS_Pedr
CGI080
CONPL_Ton
conf_alva
Conf_jorg
EPS_Carlo
Eps_Mirko
ESH0_Rob
ESH0_Alex
ESH0_hag
ESH0_Mort
HARN_albe
HARN_xavi
infra_lar
LGL_Team
Hias_Dani
Hias_Rub
HAC_Ake
OBC_Danny
OBDH_Irel
pawelk
PROP_Flo
PR_manu
RAD_David
RAD_Hanss
simu_dani
Sys_Joerg
Vincenzo

Start mIRC - [... Neil Melvil... Free Agen... TextPad - ... Trilian jody kirch... Corel PHO... 14:16

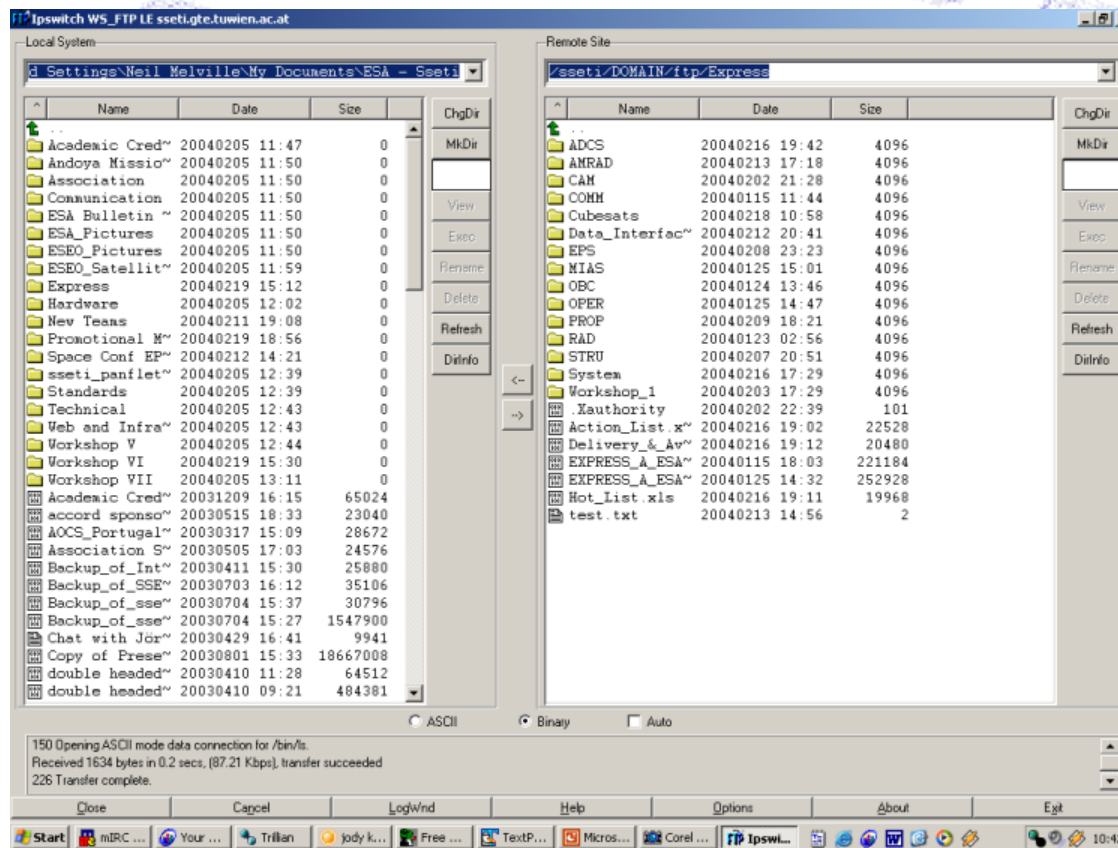
Communication Tools

- **News Server:** A standard NNTP news server provides a structured nest of newsgroups that used for a wide variety of both technical and managerial discussions. This solution allows a highly visible, traceable, dynamic and permanent information network.



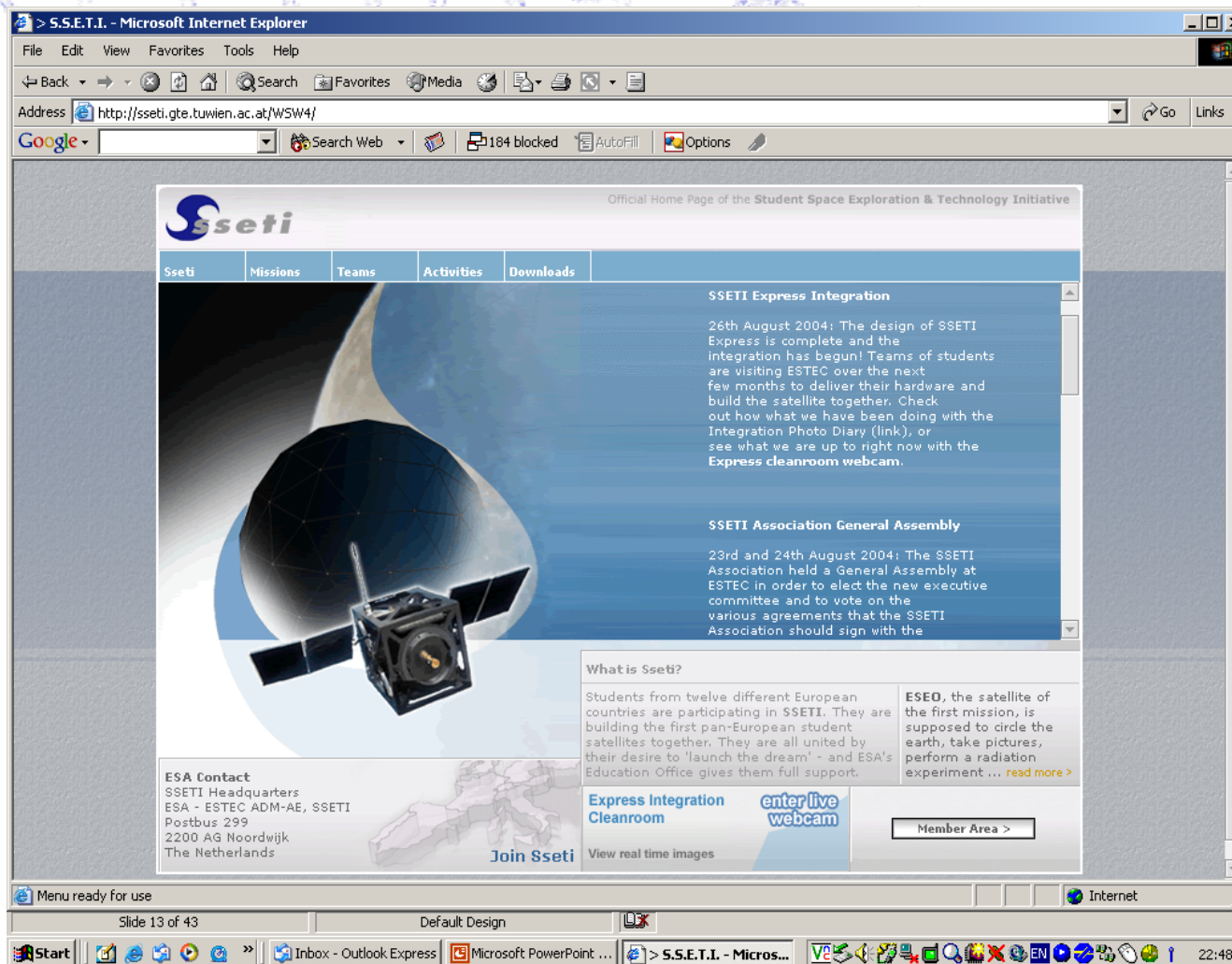
Communication Tools

- **File Transfer Protocol Server:** A standard FTP server is used as a structured storage device for all documentation within the SSETI programme. Separate team logins ensure a suitable mixture of visibility and security.



Communication Tools

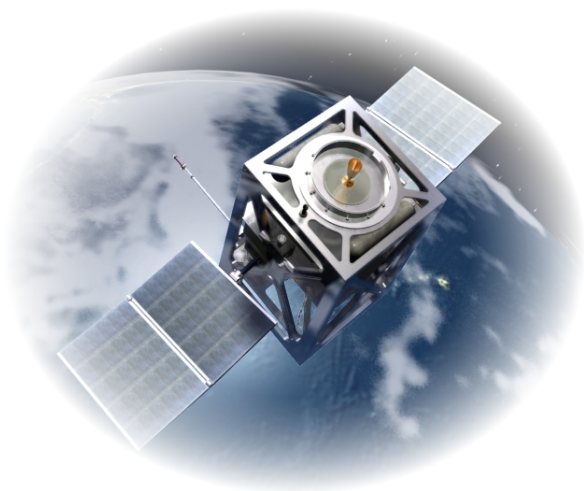
- **Web Server:** The SSETI website (www.sseti.net) not only provides the main Public Face of SSETI but also a members area with a database of team contact information and details of the projects.



Workshops

- Organised by SSETI Management about twice per year per project
- Two students are selected to represent each team and sponsored by the Education Office to attend the workshops at ESTEC
- Provides an opportunities for teams to meet each other face-to-face and interact quickly and efficiently on technical issues
- Promotes project-team building and allows individual teams to develop coherent high-level perspectives
- Primary interface between the students and ESA experts via formal reviews of work performed by the teams
- An ideal platform for SSETI Association AGMs
- **Extremely productive**



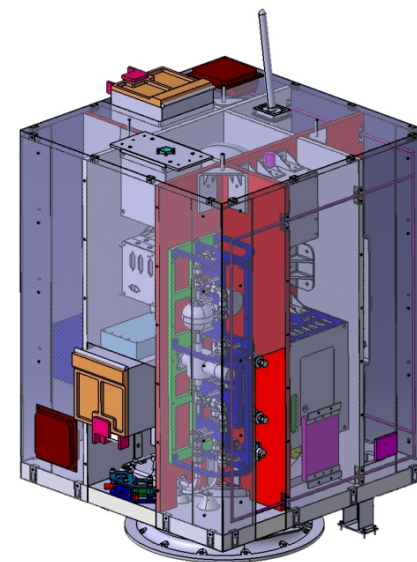


European Student Earth Orbiter

- First project, began October 2000
- Earth observation micro-sat (120kg)
- Entirely designed and implemented by students
- Launch late 2005 as Ariane 5 secondary payload

SSETI Express

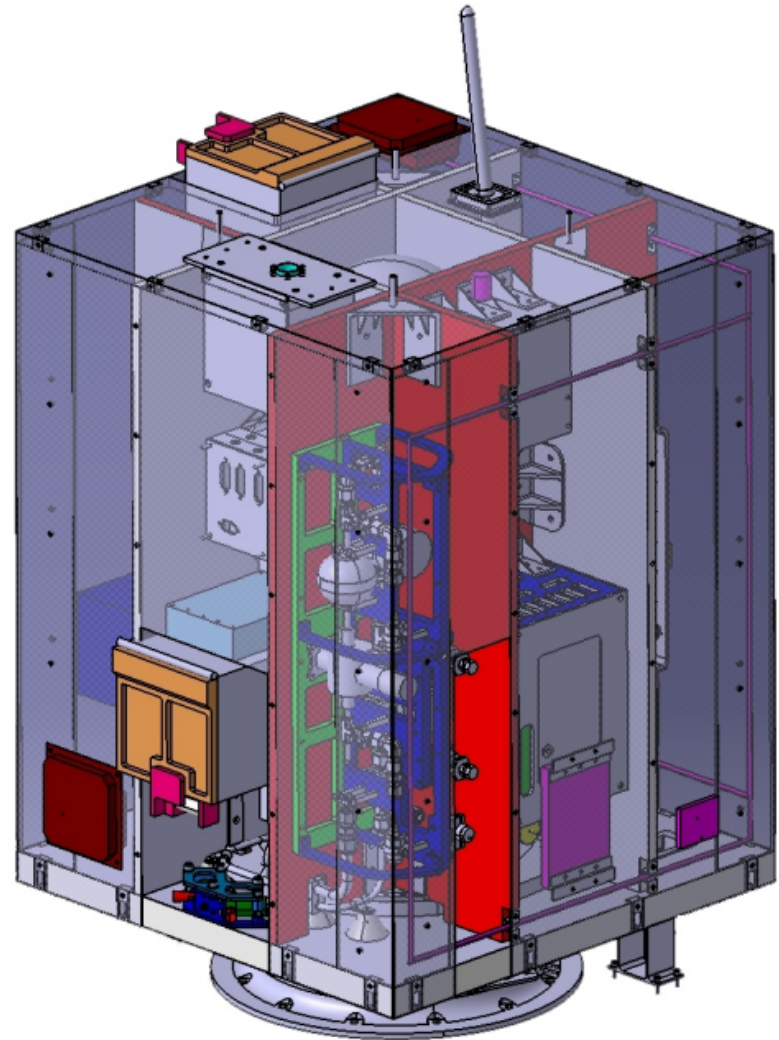
- Fast mission, began December 2003
- Utilising existing or highly developed hardware
- Earth observation and technology demonstration
- Simple but effective design
- Launch May 2005 *Kosmos*



European Student Moon Orbiter

- Project scheduled to begin late 2004
- Preliminary feasibility studies underway

sseti EXPRESS



Mission Parameters

- **Project initiation:** 5th December 2003
- **Dimensions:** 60x60x70cm, Mass: ~80Kg
- **Orbit:** 98° Sun-Synchronous, 686 Km, 11:00 LTAN
- **Stabilisation:** Quasi-active 2-axis magnetic
- **Communications:** TX/RX UHF @ 437MHz, TX S-Band @ 2.4GHz
- **Groundstations:** Aalborg University and Svalsat (Svalbard)
- **Duration:** Primary mission can be completed in 1-3 months
- **Integration Site:** ESTEC
- **Models:** Protoflight only
- **Verification:** To ASAP standard (or as close as possible)
- **Launcher:** Cosmos DMC-3 with SSTL, from Plesetsk (65.5°N)
- **Launch Window Opens:** May 2005



The Concept

- Fast mission to act as a demonstration of capability
- Intended to serve as a test-bed for ESEO hardware
- Increases motivation and experience of SSETI Students
- Improves relations between other educational satellite programmes
- Search for existing or fully designed hardware
- 'Construct' mission from this hardware



Mission Statement

"The SSETI Express mission is an educational mission that shall deploy CUBESAT pico-satellites developed by universities, take pictures of the Earth, and act as a test-bed and technology demonstration for hardware of the complementary project: the European Student Earth Orbiter"



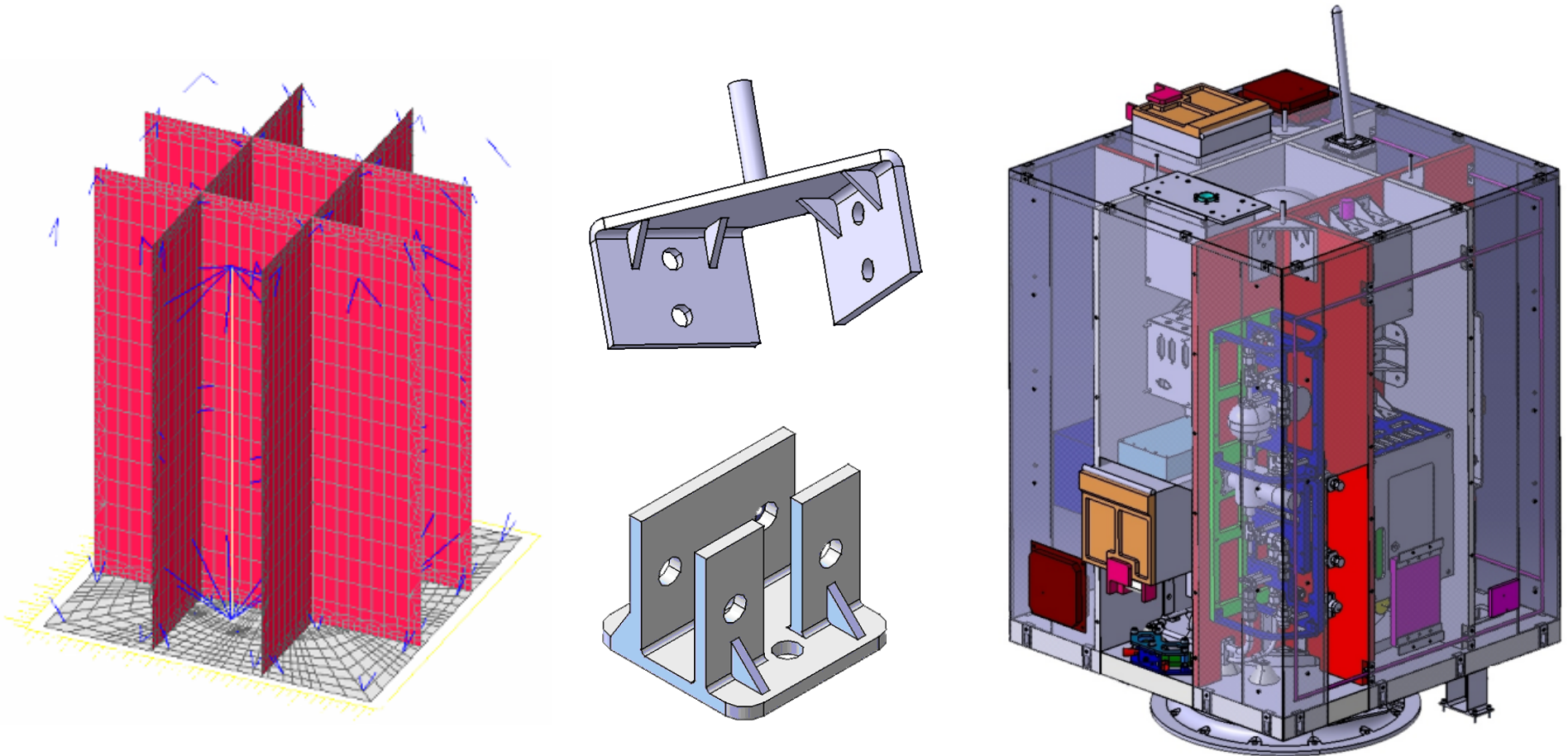
Mission Objectives

- 1) To demonstrate the successful implementation of this pan-European Educational initiative and therefore encourage, motivate and challenge students to improve their education and literacy in the field of space research and exploration,
- 2) To carry as passengers, and subsequently deploy, three educational CUBESAT pico-satellites,
- 3) To demonstrate and test the hardware and technology being developed for the European Student Earth Orbiter,
- 4) To take pictures of the Earth,
- 5) **To involve the global Radio Amateur community in the downlink of telemetry and payload data from the satellite, and to provide a UHF/S-BAND transponder until mission termination.**

Structure

- Structure:** The physical structure of SSETI Express is based upon that of the European Student Earth Orbiter

This allows an extensive feedback loop of knowledge, expertise and experience between SSETI Express and ESEO



Primary Payload (1)

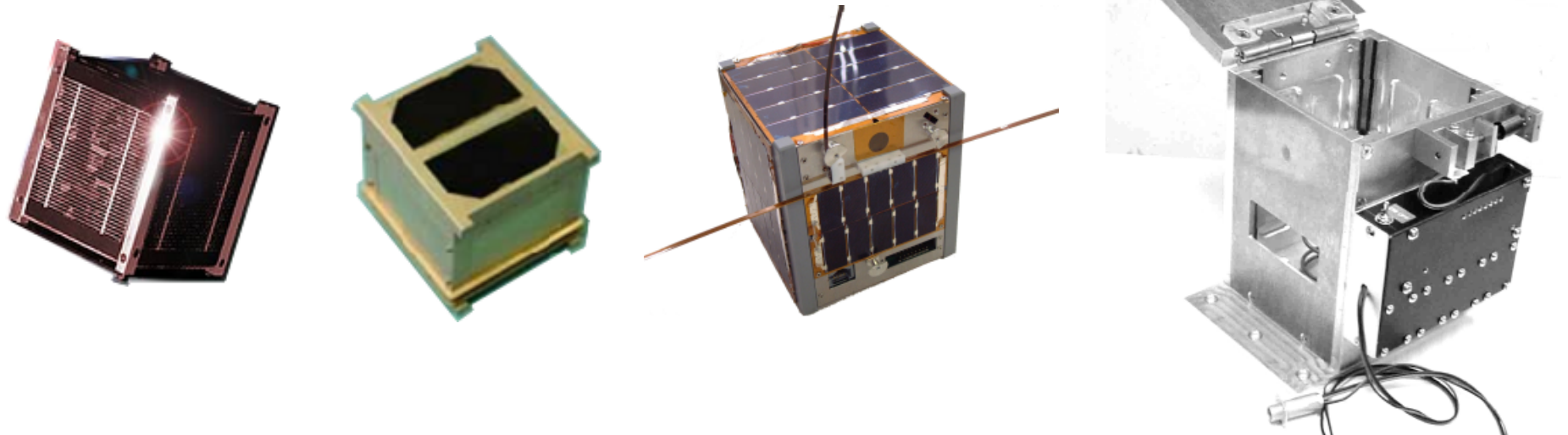
- Three Educational Cubesat pico-satellites, with deployment pods
- Passengers selected:

NCube-2 (Norwegian CUBEsat 2), Norwegian Space Centre

UWE-1 (Universität Würzburg's Experimental-Satellit 1), Germany

Xi-V (Intelligent Space Systems Laboratory), University Of Tokyo

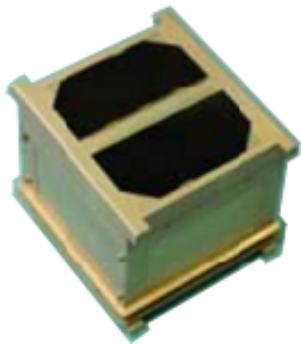
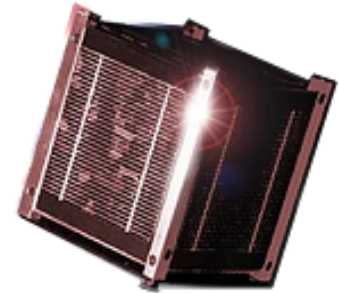
Deployment using NLS / T-Pods, developed by University of Toronto and University of Tokyo



Primary Payload (2) (Freqs Provisional)

NCube-1 (Norwegian CUBEsat 1), Norwegian Space Centre

- Maritime position and velocity tracking
- Uplink 145.980 MHz, Antenna: Monopole
- Downlink Frequencies: 437.305 MHz, Antenna: Monopole, EIRP 0.7 Watt
2407.250 MHz, Antenna: Patch, EIRP 2.5 Watt

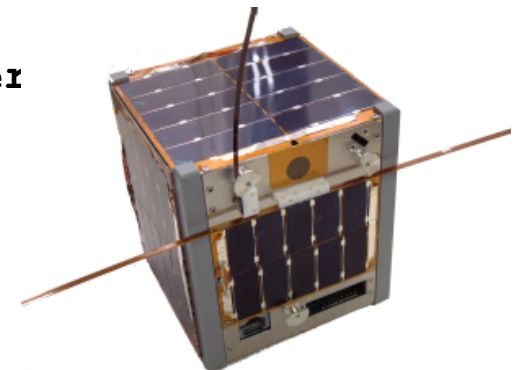


UWE-1 (Universität Würzburg's Experimental-Sat 1), Germany

- Experimental telecommunications protocol development
- Derive robust variants between UDP/IP and TCP/IP
- Up and down: 435 MHz and 144 MHz

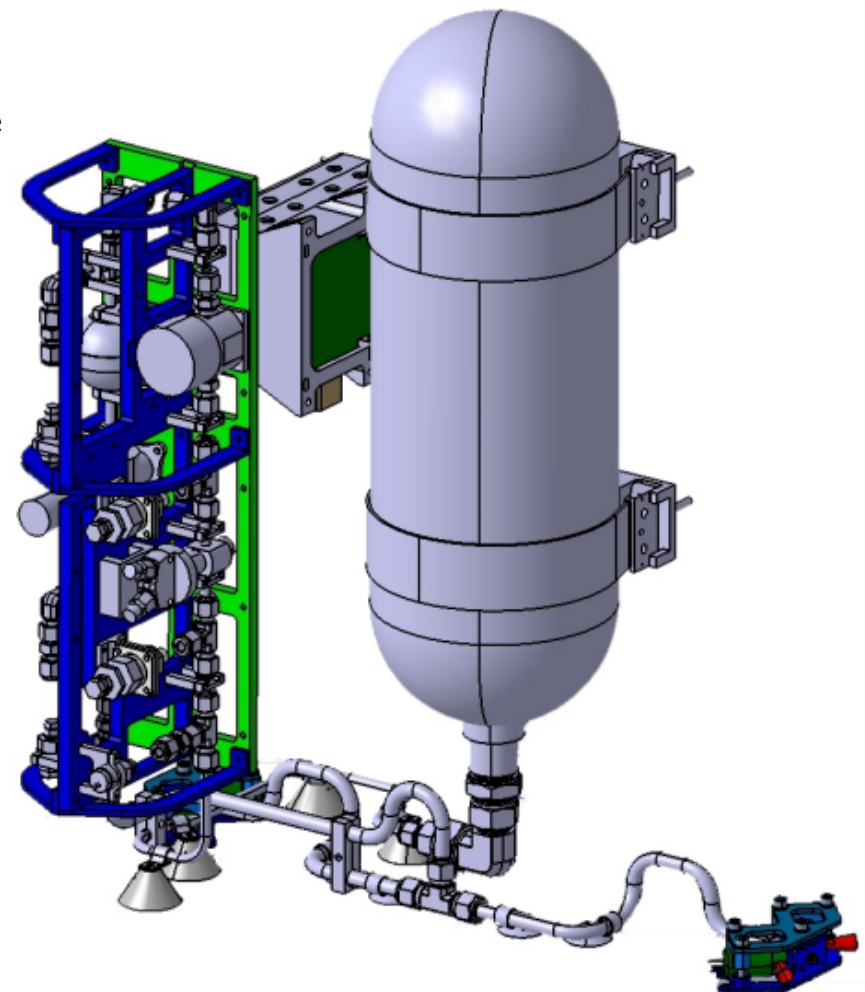
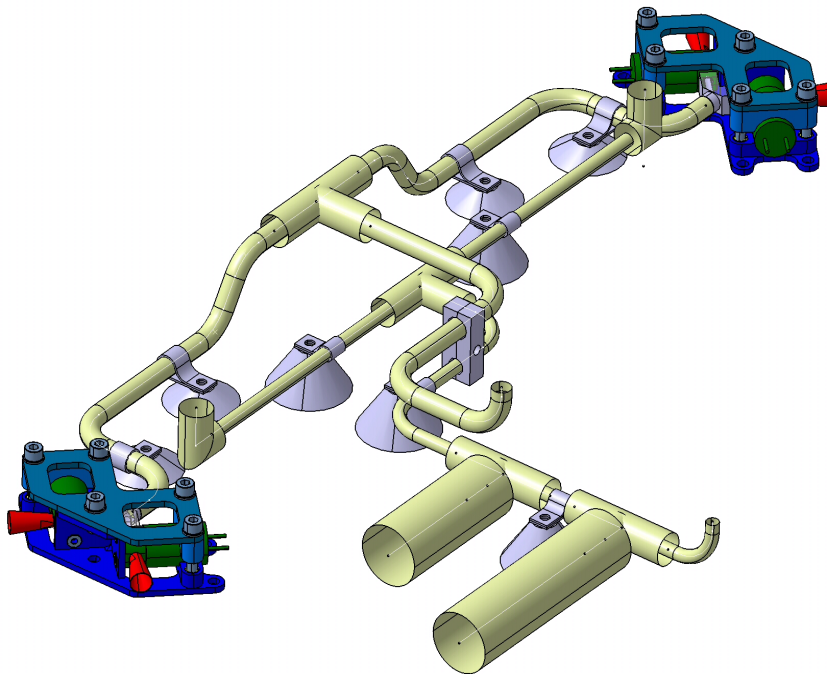
Xi-V (Intelligent Space Systems Laboratory), Univer

- Demonstration of COTS and miniature camera
- Downlink FM, 437.480-437.500 MHz (Peak power: 1 W)
- Beacon, 436.845-436.850 MHz (Peak power: 100mW)



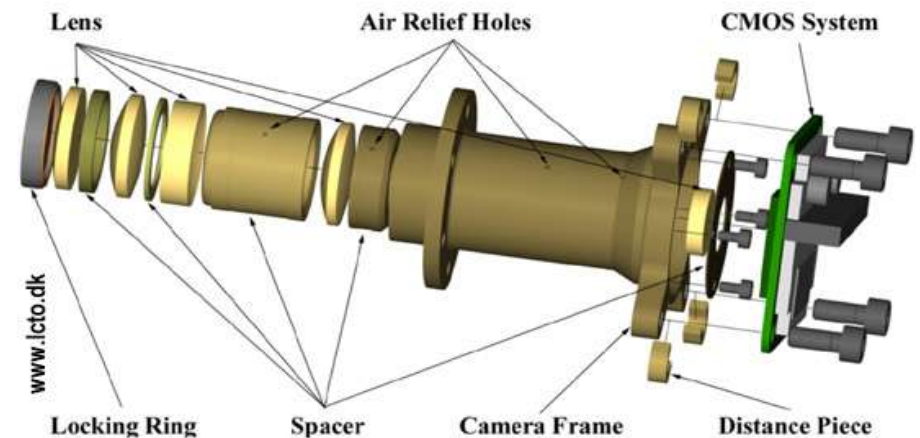
Secondary Payload

- Technology demonstration of the attitude control propulsion system from the European Student Earth Orbiter (sister satellite)
- Two clusters of cold-gas thrusters
- In-orbit testing will commission hardware and characterise performance



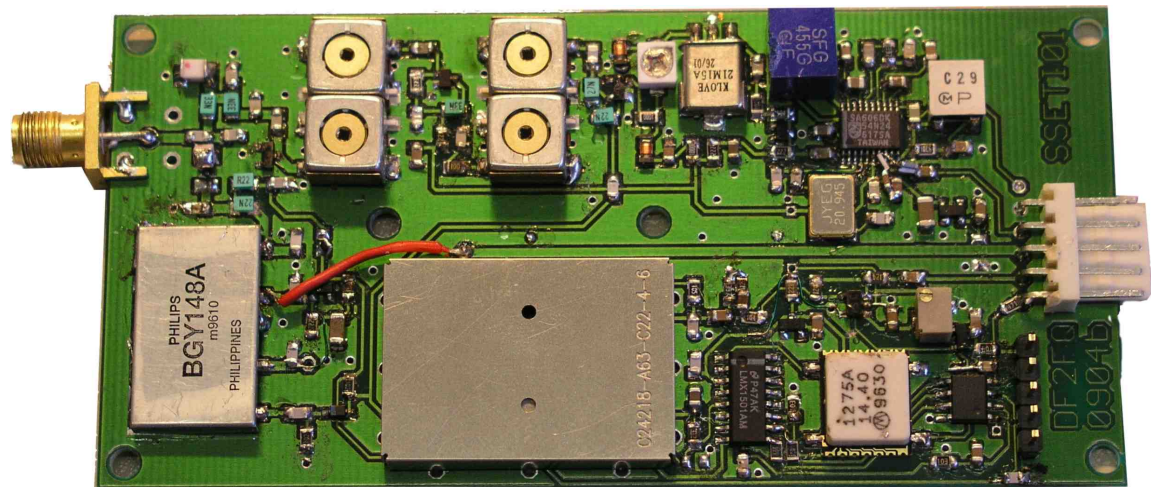
Tertiary Payload

- Miniature camera (flight spare of the unit from AAU Cubesat)
- Unit shall be used to take pictures of Earth, and possibly also of the launcher and the Cubesat passengers



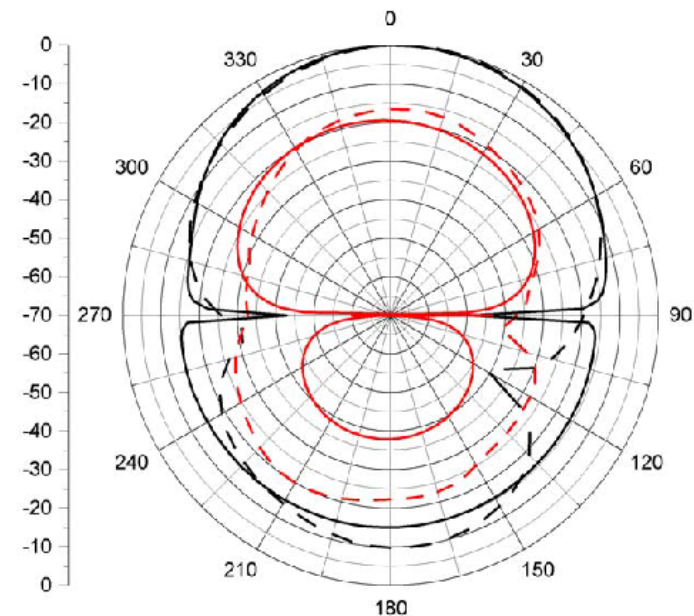
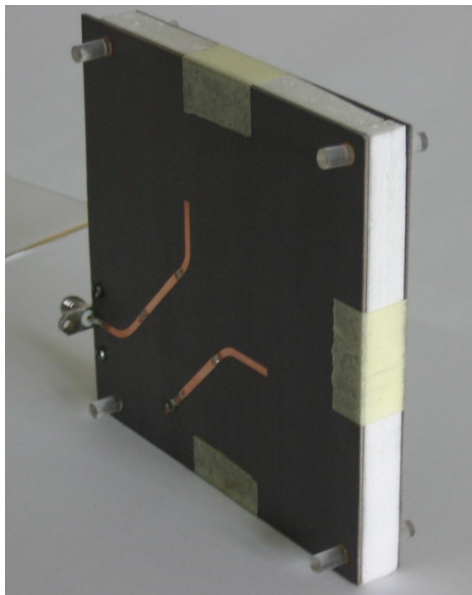
Transponder Design (1)

- **UHF Radio and Modem:** The UHF transceiver system for SSETI Express is being generously provided by Holger Eckardt DF2FQ.
- Simple solution, Single channel
- Uplink and downlink at 437.2875 MHz, 15kHz bandwidth (provisional)
- Output power of 3W EIRP, with 0dB antenna gain
- Receiver sensitivity of 0.4 μ V
- 9600bps FSK modulation, G3RUH-compatible
- Simple inclined quarter-wave monopole antenna (borrowed from an ESA Meteosat)
- Will use standard un-numbered AX25 encoding



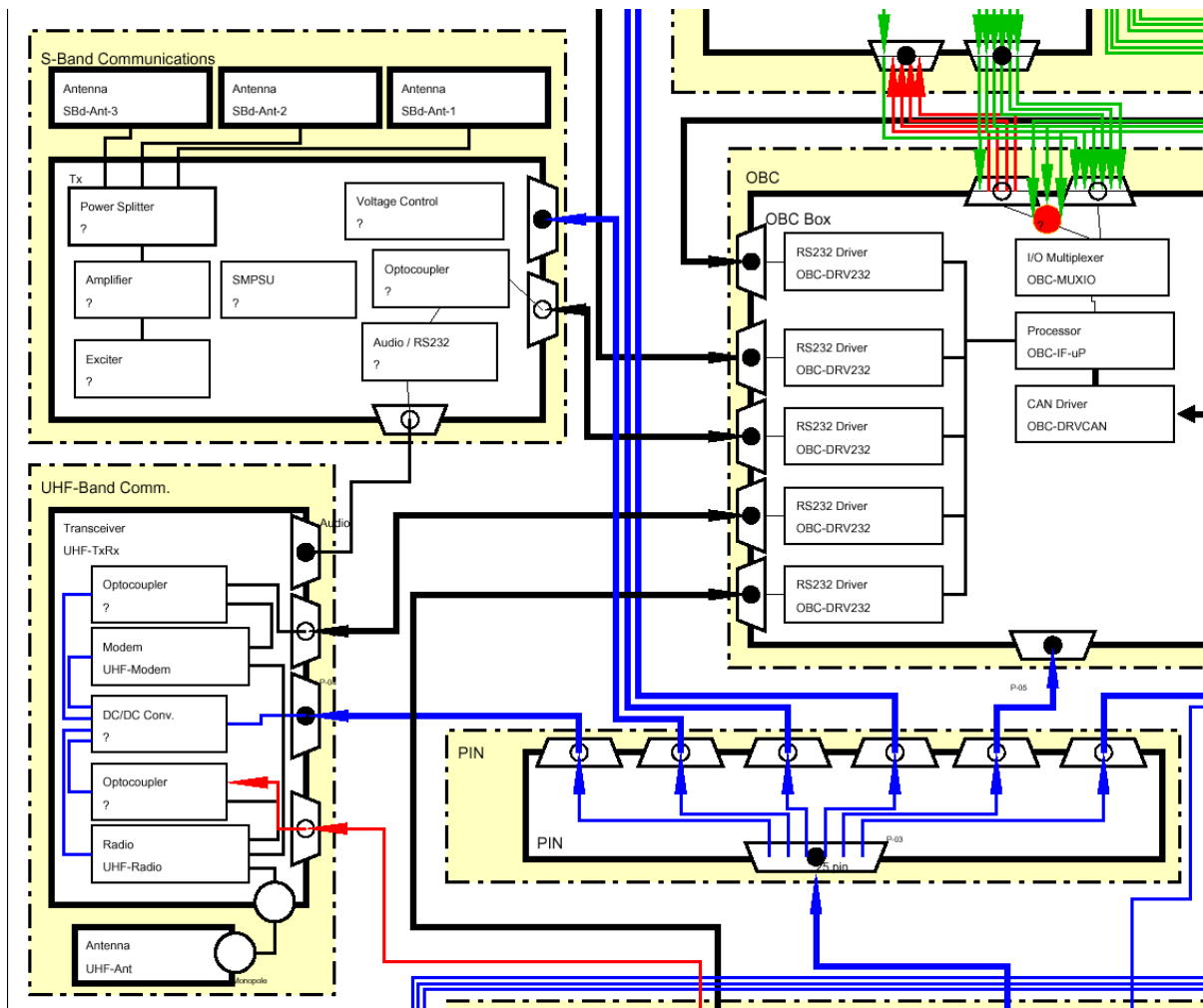
Transponder Design (2)

- **S-BAND Radio and TNC:** The S-Band system for SSETI Express is being developed and implemented by a team of Radio Amateurs from AMSAT-UK
- Transmit only, for telemetry downlink and transponder functionality
- Transmit on 2401.840 MHz, power 2W, (provisional)
- 38k4 data downlink with NBFM capability
- Three 8 dBi RHCP patch antennas developed by University of Wroclaw



Transponder Design (3)

- **FUNCTIONALITY:** The transponder mode will be enabled in full once the primary mission objectives are complete
 - There will probably be a few test runs beforehand
 - Does **not** require the on-board computer at all
 - Functionality implemented via control tones from the ground
 - Appropriate details will be published on the SSETI webpages closer to the time
 - Free and unrestricted use until platform failure
- (All data downlink details will also be made available and a competition won for the amateur providing us with the most data)



The S Band Transmitter

The pre-project phase

- An ARISS International Meeting in March 2004 at ESA's ESTEC facility.
- Discussions regarding frequency coordination of the UHF and S band on board systems.
- The required S band transmitter was going to be costly and possibly late
- We offered to produce one for them FREE OF CHARGE - well almost
- At the end of May 2004 this offer was accepted

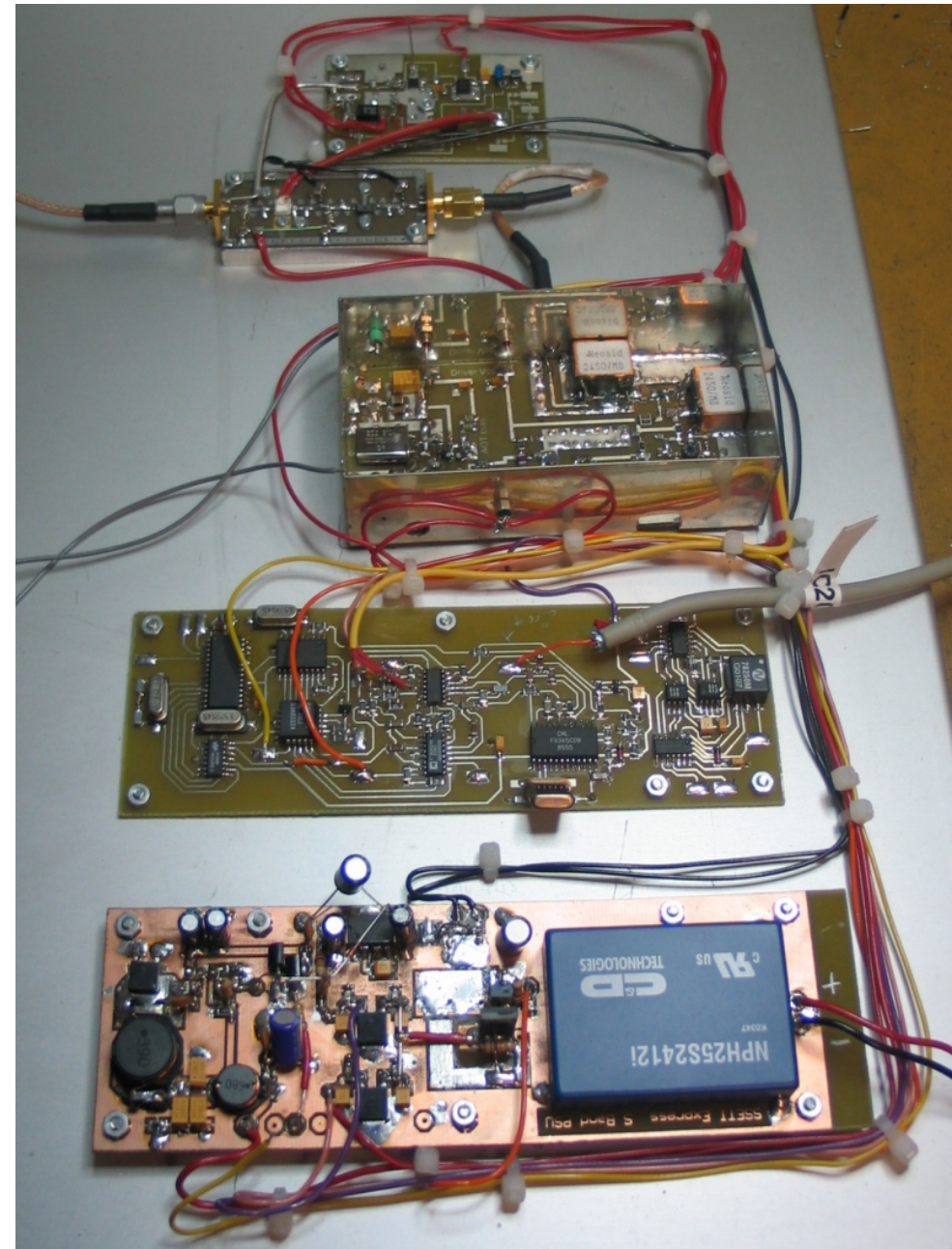
The AMSAT-UK S Band Transmitter

The design and construction phase

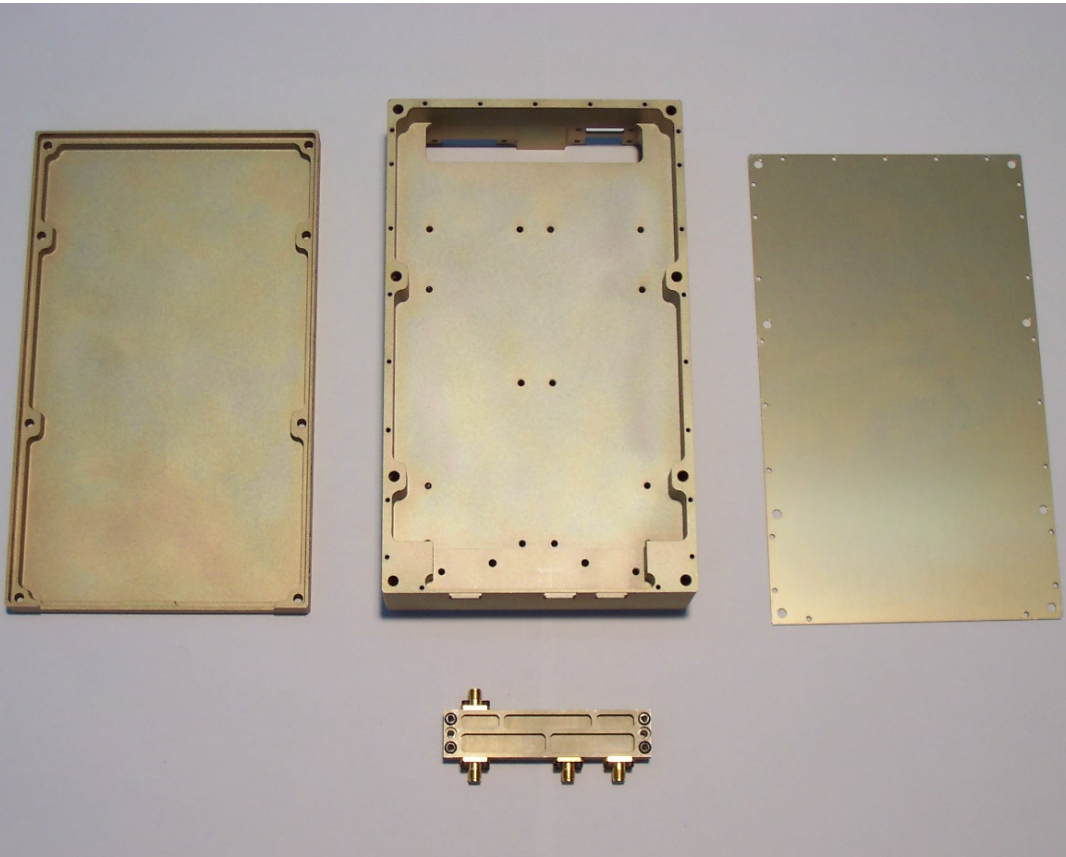
- Started with Charlie G3WDG's 3 watt S band PA – now flight qualified in Oscar 51
 - A team of five from AMSAT-UK, Sam-G4DKK, David-G0MRF, Jason-G7OCD and Howard-G6LVB
 - Sam – Tx driver and modulator
 - David – SWMPSU
 - Jason – TNC & control interfaces
 - Howard – Ground segment & testing
-
- Kick off meeting – 16th June 2004
 - Test bed model demonstrated fully functional in 38k4 data and NBFM modes – 16th August 2004
 - Flight model will be complete in enclosure mid October~



The AMSAT-UK S Band Transmitter Test bed model



The AMSAT-UK S Band Transmitter Engineering model enclosure

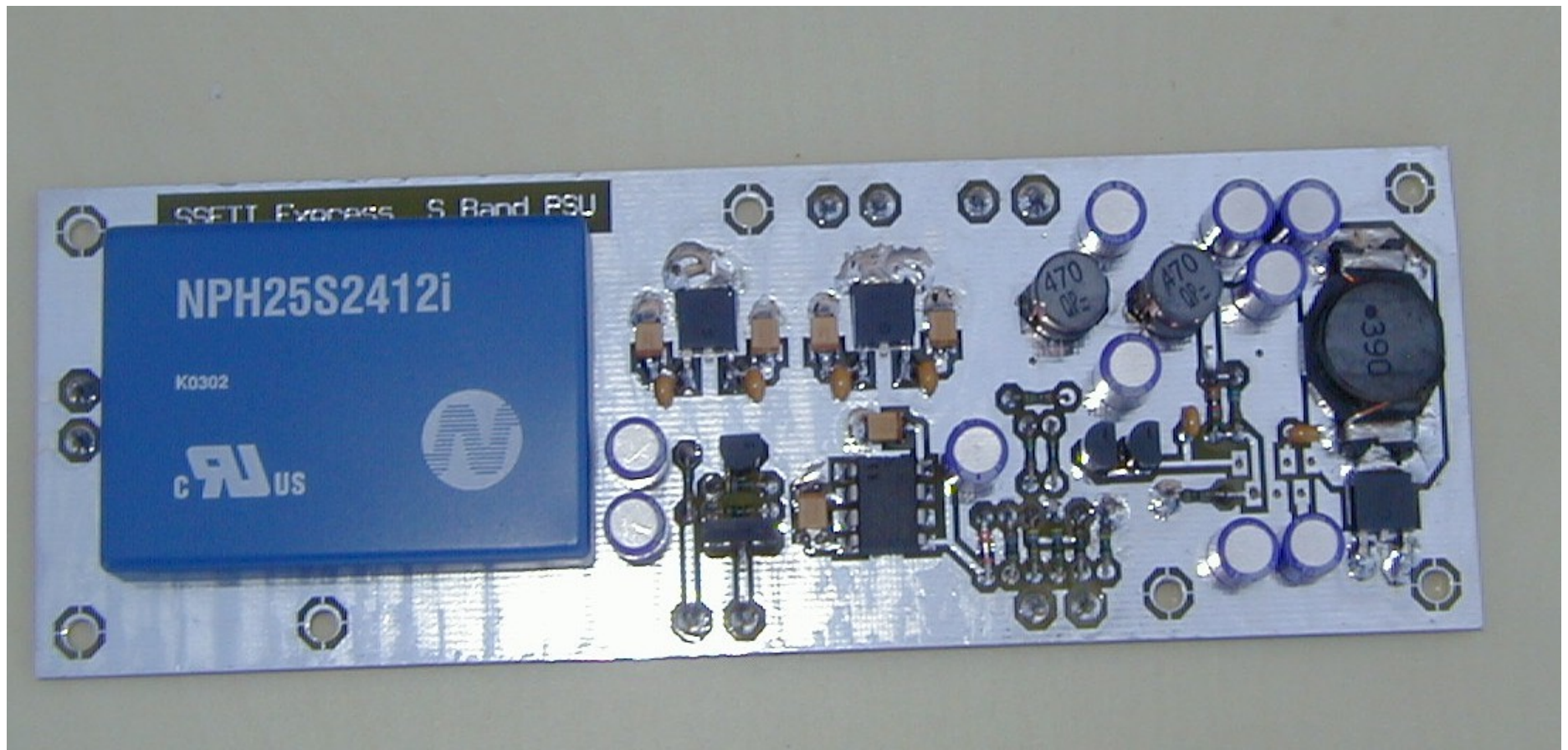


The AMSAT-UK S Band Transmitter Test fitting into the engineering model enclosure



The AMSAT-UK S Band Transmitter

The switch mode power supply

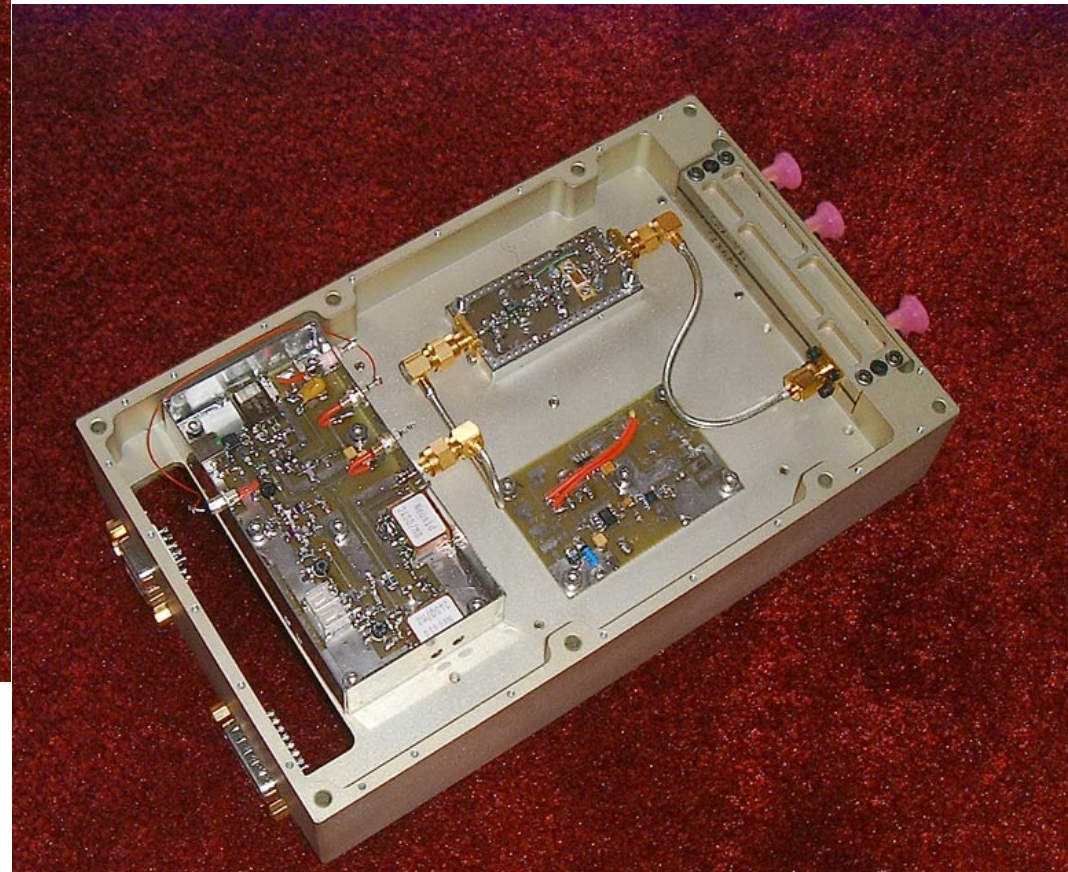


The AMSAT-UK S Band Transmitter
The flight model enclosure has arrived!



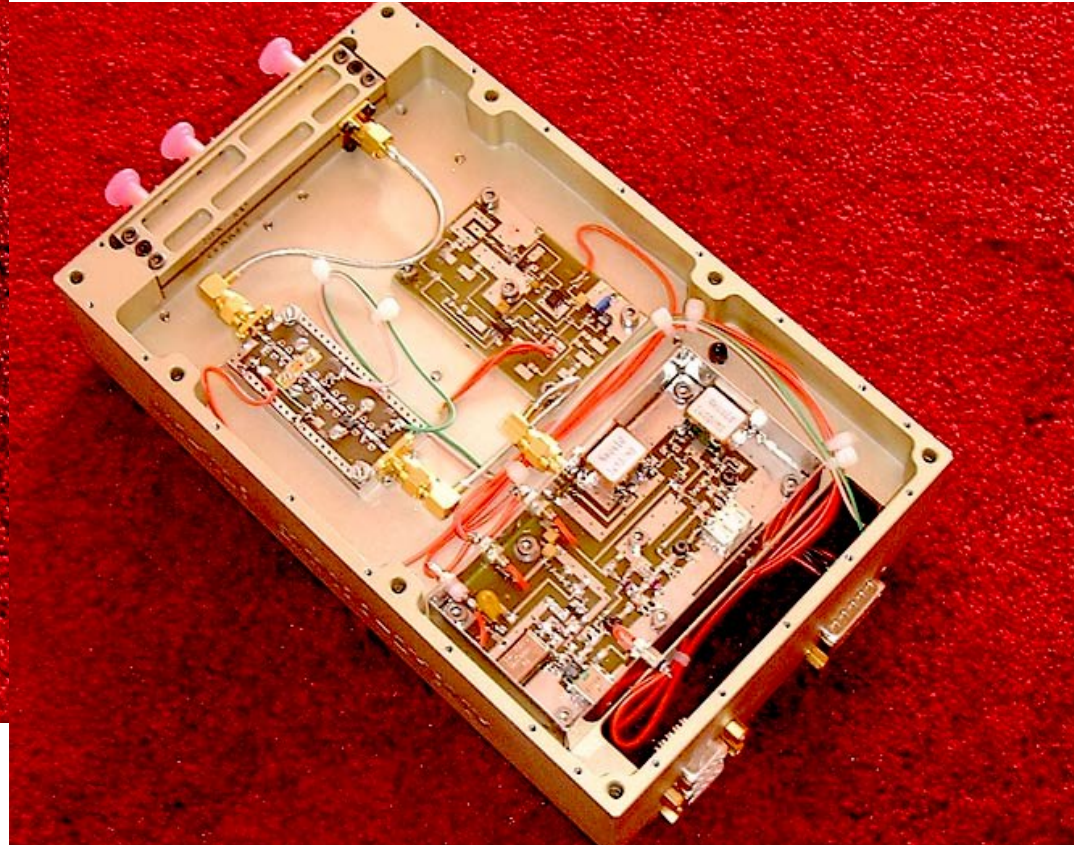
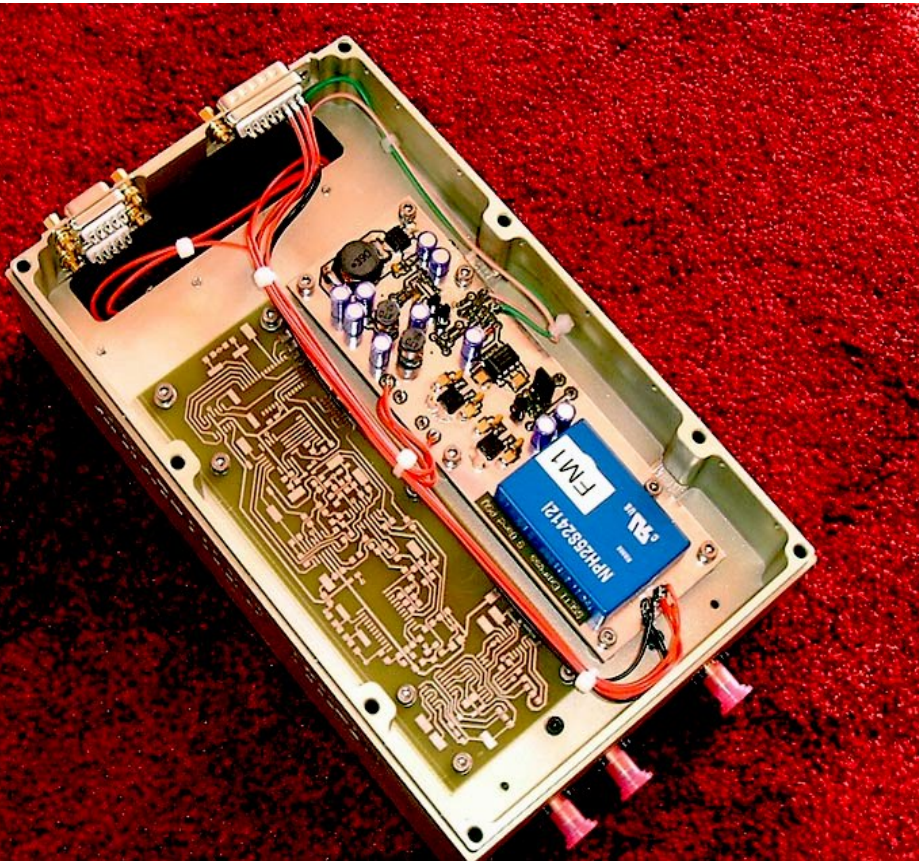
The AMSAT-UK S Band Transmitter

The flight model is being assembled!

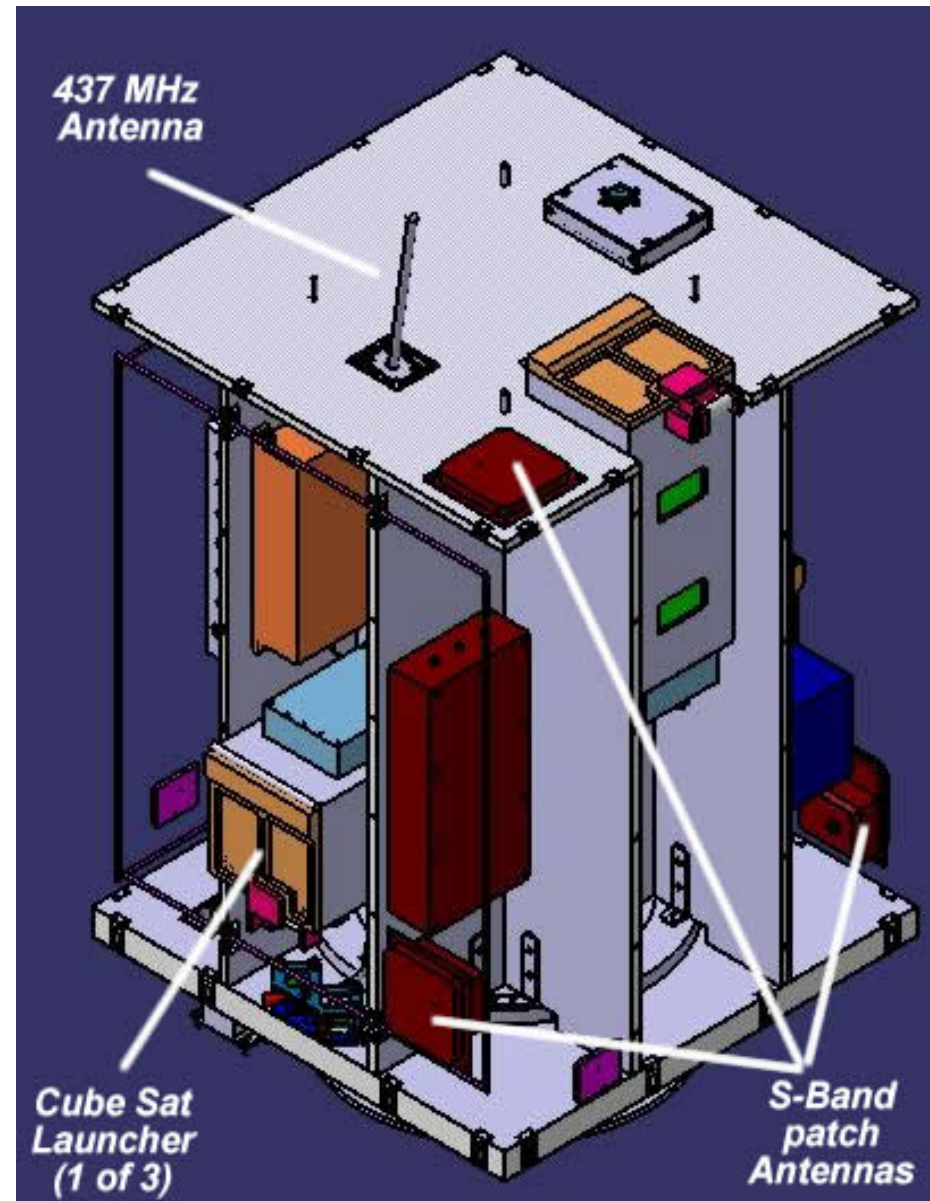
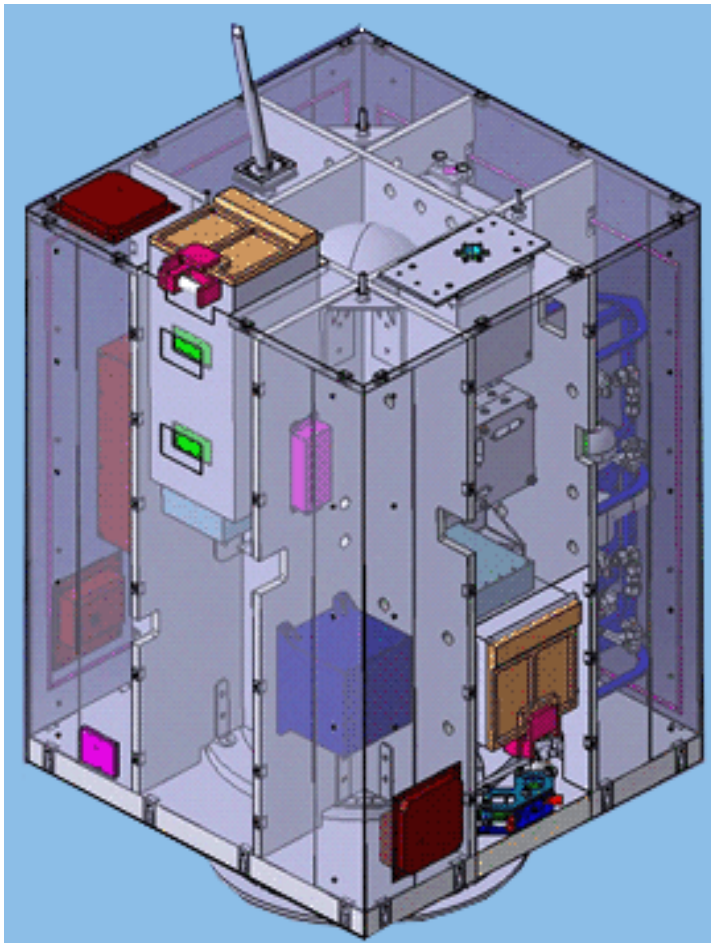


The AMSAT-UK S Band Transmitter

The flight model is being assembled!



The AMSAT-UK S Band Transmitter Integration with spacecraft



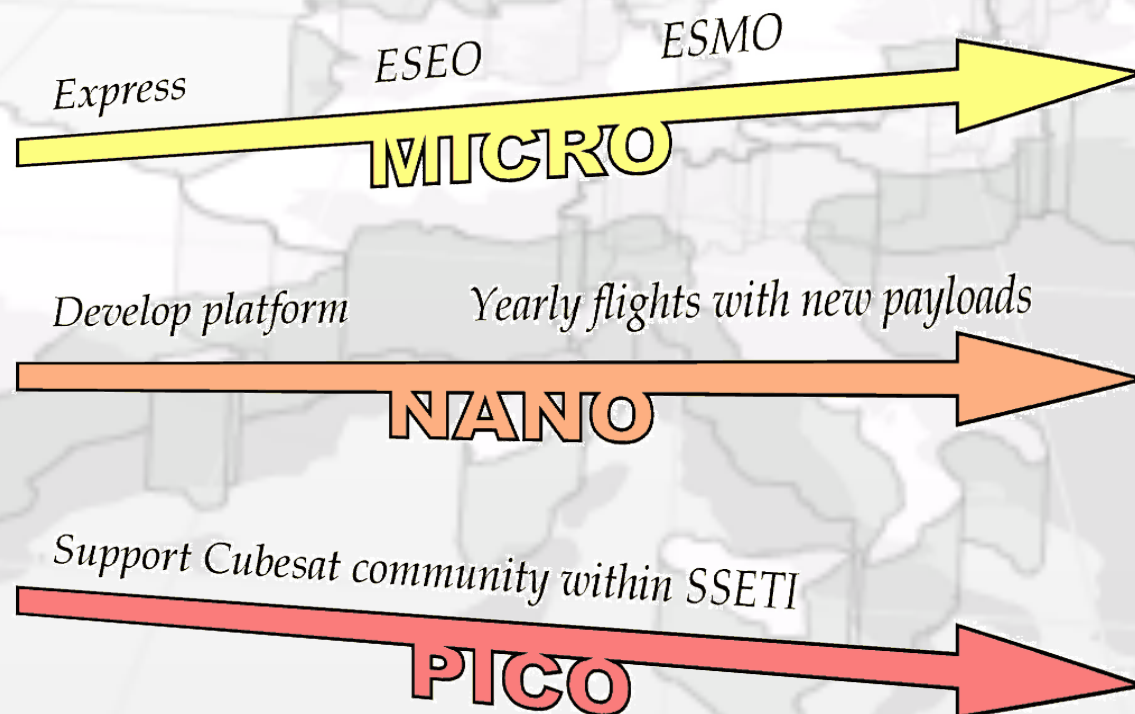
The AMSAT-UK S Band Transmitter

Planned operation

- **Initial data configuration:** After Cubesat launches the UHF and S band transmitters will be used to downlink telemetry data. ESA will be offering a prize for the amateur who provides them with the most valid data.
- **Transponder configuration:** UHF FM voice uplink with a 67Hz tone will be downlinked on S band. Limited telemetry will be provided.
- **Mission lifetime:** Initial configuration expected to be completed within 1-3 months. Transponder configuration will continue until failure of any one of the many mission critical components

The Future for the SSETI program – and perhaps for more AMSAT transponders

- Multiple threads with different classes of satellite
- Improved links to other communities (such as AMSAT)
- **Repeated cooperation with Radio Amateurs for mutual communications solutions and support**
- A general support network for **all** student satellite activity in Europe, coordinating cooperation on design, implementation, testing, launch and operations



Our fingers are crossed!

and thank you Neil Melville and ESA for the
opportunity